HIGHLIGHTS OF RESEARCH

Outstanding Features Appearing in

This Month's Issue

How Research Pays

Nylon was acclaimed by industrial chemists as one of the most important chemical discoveries of the last decade. But if it had not been for research, there would be no Nylon today. (See page 2.)

The Secret Weapon

Fuller E. Callaway, Jr., vice-president of the United States Institute for Textile Research, hails research as the secret weapon with which man's foes may be overcome and his life made better. (See page 10.)

Mixed-Fabric Analysis

Growing use of other fibers in admixture with wool and recent legislation making mandatory the labeling of wool products necessitate the development of standard methods for analyzing such mixtures. (See page 14.)

Wool Can Be Improved

A chemically modified wool which is strongly resistant to attack by moths, bacteria, molds, and many chemicals has been achieved as a result of research. (See page 19.)

Sound Inventory Policies

Textile manufacturers should begin now to consider what production and inventory policies they are going to follow when demand for their products begins to waver. (See page 26.)

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Development of Nylon Yarn Is Striking Example of

How Research Pays

STRONGER AND MORE ELASTIC than silk, wool, linen, or cotton, Nylon yarn was hailed by industrial chemists as one of the most important chemical discoveries of the last decade. From the standpoint of textile manufacturers, development of this synthetic fiber promises to be more far-reaching in its effects than was introduction of "artificial silk" by Chardonnet. Already Nylon has proved suitable for use in making parachute fabrics and thus has insured the United States against shortages of silk due to stoppage of imports from Japan. Already Nylon stockings have demonstrated their superiority, until the demand far exceeds the supply. Already Nylon is bringing new techniques and a new philosophy to the textile industry. But if it had not been for research, there would be no Nylon today.

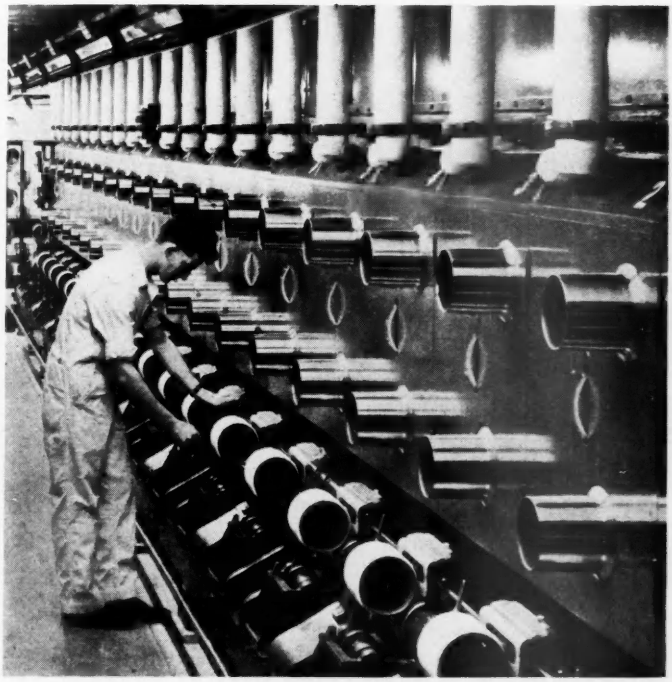
Improvement of Products

It was in 1928 that Dr. Charles M. A. Stine, then chemical director of E. I. du Pont de Nemours & Co., persuaded that company to embark on a program of fundamental research. For many years du Pont had carried out applied research directed to the improvement of existing products or development of new ones. Now a broader program was begun, designed primarily to unearth fundamental information concerning chemical products and processes. The work was started with no thought that the data developed would have any immediate practical value or that the company would obtain a quick return on the money invested in the project. Dr.

Wallace H. Carothers was selected to head the small group of highly trained organic chemists which was to engage in this fundamental research.

The first investigation undertaken was directed toward a better understanding of how and why relatively small molecules of matter, such as those of water, air and coal, unite to form giant molecules, such as those found in rubber, cellulose, and resins. When two or more like molecules are made to unite, the larger molecule thus formed is called a "polymer," and the process by which they are caused to unite is termed "polymerization." Out of the study of polymerization begun by du Pont in 1928, fundamental information of great academic interest

Winding Nylon filaments on tubes after extrusion through spinnerettes



was developed. It was demonstrated, for example, that certain small molecules could be made to join together end to end somewhat like a chain of paper clips.

Then, after this fundamental research had been going on for about two years, something happened. One of the group of eager young chemists working on this polymerization problem was experimenting with a new type of long-chain superpolymer. In attempting to remove a sample of this material from the still in which it had been prepared, he noted that the molten mass could be drawn out in the form of a long, continuous fiber something like silk in appearance.

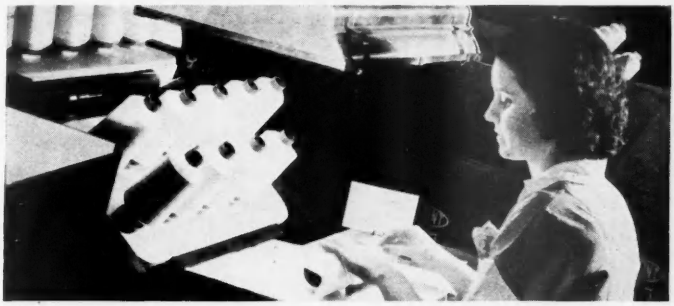
Original Fiber a Curiosity

This original fiber was not very strong; it was not very elastic; and it was softened by hot water. It was a curiosity with no practical value. But to du Pont's research men it suggested the possibility that some related type of superpolymer might produce fibers possessing desirable characteristics suitable for textile use.

Accordingly, further research was undertaken to determine whether it was possible to synthesize a superpolymer from which usable textile fibers could be drawn or spun. The work now took on a less theoretical aspect and became applied research devoted to the development of a new product.

Many difficulties were encountered in synthesizing a superpolymer from which satisfactory fibers could be produced. The outlook was so dark at one time that consideration was given to suspending this particular line of applied research. But the work did not cease. And finally a superpolymer of a different type was prepared, known as a "polyamide," from which fibers spun by hand were found to possess such characteristics as to warrant extraordinary efforts to bring the development to commercial success.

Much work was to be done, however, between the day when the first polyamide fiber was extruded through an



Inspecting Nylon before shipping

improvised spinneret made from a hypodermic needle, and the day when Nylon became a practical accomplishment. Hundreds of different polyamides had to be synthesized before superpolymers having the desired characteristics were found. Sources of raw materials for making the superpolymers had to be investigated. Laboratory processes for making the superpolymers and the fibers had to be transformed into plant-scale operations. In 1938, just ten years after the fundamental research on polymers was started by the du Pont laboratories, Wallace Carothers was granted a patent covering the production of "synthetic linear condensation polyamides, and filaments, fibers, yarns, fabrics, and the like prepared therefrom." On Dec. 15, 1939, commercial production of Nylon yarn was started by the du Pont company.

Most of the rest of the story of Nylon is well known to textile men. They are familiar with its properties. They are aware of its present and potential applications in the textile industry. They are beginning to realize its impact on textile philosophy and technique—that with the advent of this, the first truly synthetic fiber, came the possibility of "making fibers to order" to suit particular needs and purposes. They should not forget that Nylon is the result of long and painstaking work—first in the realm of pure or fundamental research and then in the field of applied research.

RESEARCH ACTIVITIES

The annual meeting of the United States Institute for Textile Research will be held Friday, Nov. 14, at the Hotel Roosevelt, Madison Ave. and 45th St., New York. Directors meeting starts at 10:45 a.m.; members business meeting, including election of officers at 11:30 a.m.; luncheon session and round-table discussion at 1 p.m. Program of subjects to be discussed appears on page 18.

Tests for fiber length, strength, fineness, cellulose alignment, and spinning properties of cotton are to be conducted by the Governmnet on a fee basis. Full details on requirements as to samples and cost of tests can be obtained from the Chief of Agricultural Marketing Service, U. S. Department of Agriculture, Washington, D. C.

The great importance of scientific research to the defense program and to the public at large was given public recognition in an OPM order granting the high defense priority rating of A–2 to equipment needed by research laboratories. A laboratory experiencing difficulty in securing essential materials and wishing to qualify for the A–2 rating, should apply to the chemical branch, Office of Production Management, Washington, D. C., on Form PD–88. The preference rating may be extended as far as necessary to assure ultimate delivery of scarce materials to the laboratory. In the event that the laboratory still finds itself unable to obtain some essential material with the A–2 rating, it should file an application with the priorities division on Form PD–1. If the research project is deemed of sufficient importance, the priorities division will issue an individual preference rating certificate, showing

a higher rating to a particular delivery of specified material.

The Texas Legislature has appropriated $250,000 for establishment of a cotton research laboratory. An advisory committee including Dr. T. O. Walton, president, Texas Agriculture & Military College; Dr. Homer P. Rainey, president, University of Texas; and Cliff B. Jones, president, Texas Technological College; has been appointed by the State-Wide Cotton Committee of Texas to cooperate with a committee designated in the bill passed by the Legislature.

Prof. George H. Dunlap, director of the research program being carried out under sponsorship of the Textile Foundation by the Southern Textile Association and the Arkwrights was one of the speakers at a recent meeting in Gastonia, N. C., of the Gaston County Division of the S. T. A. Professor Dunlap described the type of researches which he is conducting in several southern mills. These include: (1) determination of proper temperature on slasher cylinders; (2) effect on yarn properties of various roll settings in long-draft roving; (3) study of finished fabrics made from yarns spun with various twist multipliers; and (4) investigation of variation in picker laps made on single-process picker with and without blending reserve. Professor Dunlap locates men in the mills who are willing to make the tests and then lays out a program for the tests. Having started a test in one mill, he endeavors to have the same test made in several mills so as to eliminate errors which may be due to conditions peculiar to one mill.

Herbert F. Schiefer and Richard S. Cleveland of the National Bureau of Standards, Washington, D. C., have recently conducted a series of tests which indi-

cate that breaking strength and elongation of cotton yarns vary with the rate of loading and type of testing machine. The results of these tests, made with the pendulum and inclined-plane types of machines, are expected to have an important bearing in preparation of yarn specifications and standardization of yarn testing methods.

Rapid progress is reported by the special committee of the American Association of Textile Chemists & Colorists which is cooperating with the Government in an endeavor to improve the color fastness of olive drab wool uniform fabrics. At a recent meeting of the committee 500 samples representing 150 different dye combinations which had been given weather tests at Lowell Textile Institute, under supervision of B. A. Ryberg, associate director of research for the A. A. T. C. C., were subjected to a process of comparison and elimination. Of the 150 combinations, 5 were found to have the most desirable fading characteristics, but 4 of the 5 were eliminated from consideration for the present, due to a question as to availability of some of the dyes used. The next step planned is to have one piece of uniform fabric dyed commercially according to the formula selected as best and another according to one of the next best formulas. Samples of these fabrics will then be exposed to weather, along with samples submitted by the Quartermaster Depot.

A new process for rendering cotton and other fabrics mildew resistant has been developed by Helen M. Robinson, of the Bureau of Home Economics, U. S. Department of Agriculture. In this process, the fabric is immersed first in a solution of cadmium or copper salts and then in morpholine. The insoluble

morpholine compound formed on the fibers is resistant to washing and weathering. The process is the subject of a public service patent and, therefore, is available to anyone without royalty payments.

Current textile research being carried out at Mellon Institute of Industrial Research includes a continuation of an investigation of the cotton fiber. The work, which is being done under sponsorship of the Cotton Research Foundation, is proceeding along three general lines—application of cotton for novel purposes, improvement in suitability for established uses, and study of relationship between fiber structure and properties.

J. M. Cook and J. T. Rouse in charge of the Cotton Fiber and Spinning Laboratories of the Agricultural Marketing Service, at Clemson College and at College Station, Texas, respectively, recently spent a week in Washington, D. C., where they discussed with officials of the Agricultural Marketing Service plans for carrying out the fiber and spinning research for cotton planters and others.

The work to be conducted by the Division of Research recently organized by the Cotton Textile Institute was explained to research workers in the U. S. Department of Agriculture by Dr. C. T. Murchison at a recent meeting in Washington, D. C. The division plans to survey all cotton research projects now under way, to correlate existing research activities to avoid duplication of effort, and to formulate projects which will have the greatest value to the industry. John T. Wiginton has been appointed director of the research division; he will make his headquarters at Clemson College, S. C.

For Offense or Defense, Research Is Discovered as

The Secret Weapon

By FULLER E. CALLAWAY, JR.
Vice-President, U. S. Institute for Textile Research

THE SECRET WEAPON has been discovered. Its name is research. It may be either offensive or defensive, depending on whether its wielder is an aggressor or a defender against aggression. But always it is one which cannot be resisted save by another of the same kind. It is the means of getting knowledge, not previously had, together with the ability to use that knowledge, to the end that more of man's foes may be overcome and his life made better than it was before.

The progress of civilization has been slowed by man's strange resistance to new ideas, as it has been speeded by his curiosity and ambition. Glancing back through the pages of history, we note how easily each age has fallen into the error of believing that it represented the ultimate in civilization. Our own is not free of the delusion, in spite—or perhaps because—of the unprecedented scientific and industrial advances made during the last 25 years.

Greater Wonders to Come

These amazing achievements should warn us of greater wonders yet to come. Scientific research is still young, even in the life of the universities, which are primarily responsible for its existence. The chemist will tell you that the surface has hardly been scratched. As to what tomorrow will bring forth we can only hazard a

Fuller E. Callaway, Jr., vice-president of the United States Institute for Textile Research, Inc.

guess. We know only that in all probability it will be entirely different from today. Scientists speak casually of harnessing the winds for power, of drawing upon the heat of the sun, of using the surge of the tides. Not satisfied merely to process and modify natural materials, the chemists in the last few years have begun to make in the laboratory synthetic products more suited to our purposes than the natural ones they replace.

Fibers From Sand

Fibers and fabrics are being made of cows' milk, of wood, coal, fish, and sand. Between rayon and Nylon stretches a period of 50 years, but the fate of our natural fibers and our age-old methods of manufacture was sealed with the opening by the French Academy of Sciences, in 1889, of Chardonnet's instructions for making artificial silk. In the decade and a half from 1921 to 1935 cotton showed an increased consumption of about 6%. Wool in the same period gained 17%, and silk increased production by 47%. But rayon in the same 15 years increased production 1,000%.

The ordinary conception of scientific achievement is well exemplified by Charles Goodyear's "accidental" discovery of the vulcanization of rubber. The simple fact,

of course, is that for 10 long years prior to his moment of success, Goodyear had labored unceasingly in the effort to find a method by which rubber could be made to withstand the extremes of heat and cold. The lucky accident could not have happened to one unprepared to appreciate its significance. Luck favors the man—and the industry—that has paid the price of a background of knowledge in systematic research over a long and apparently fruitless period of time.

I am not prepared to say what a program of research will do for the textile industry. If we knew that, we would have already much of the knowledge we hope to gain through research itself. I believe it may help us to improve our products, to find new uses for them, to learn to make new products, to make our products cheaper, to sell what we make more easily. It may transform the textile industry, so that we will no longer make what we make now, or so that we will not make it in the same way. The important point is that whatever happens, we shall be making it happen for our own benefit, rather than standing by and watching it happen to us, for the benefit, perchance, of someone else. **For the cost of research is of two kinds: There is the cost of doing it and the cost of not doing it. And the latter cost may easily be the greater of the two.**

This modern laboratory at Callaway [illegible]ect

Where we stood until very recently is indicated by the fact that, expressed in percentage of invested capital, expenditures for research by the textile industry were at

the bottom of the list with 0.7%. Chemicals, at the head of the list, spent 2.4%. Today we make more chemicals than are produced in Germany, England, France, Italy, Japan, and Russia all added together. All in all our chemical industry employs about 9,000 scientists and engineers and spends some $50,000,000 per year for laboratory equipment, supplies and services. In 1929 chemical production was $1,000,000,000; in 1940, more than $2,000,000,000.

Expressed in terms of employees and research workers, the following figures recently published will be suggestive. The figures represent the number of research workers for every 10,000 employees: Petroleum, 563; Chemical, 300; Rubber, 173; Electrical, 116; Automotive, 41; Paper and Pulp, 28; Food Products, 16; Iron and Steel, 15; Textiles, 2.

away ...ects the author's belief in research

Fortunately, however, the outlook for the textile industry is more hopeful today than it has ever been before. Spurred on by increasing competition, and inspired by the example of other industries, we seem to be shaking off the lethargy of centuries and turning our faces to the future. If we shall not be diverted by temporary war prosperity, or discouraged by tardy practical results; if we continue to expand and co-ordinate our efforts; if we maintain our faith and courage, and are generous in our financial support, we shall set our industry on the high plane where it belongs and reap rich rewards for ourselves and our children.

Sulphuric Acid Carbonization Method Adapted for

Mixed-Fabric Analysis

GROWING USE of other fibers in admixture with wool and recent legislation making mandatory the labeling of wool products necessitate the development and adoption of standard methods for determining the wool content of such mixtures. Considerable work on developing such methods has been carried out under the joint direction of Committee D–13 of the American Society for Testing Materials and the American Association of Textile Chemists & Colorists. A recent phase of the work has been an inter-laboratory study of the sulphuric acid and the aluminum chloride carbonization methods for analysis of wool in mixed fabrics. Results of this study indicate that the sulphuric acid method is preferable since it is more convenient, less time consuming, and better suited for standardization for routine work.

Test Procedure

The sulphuric acid method employed in the interlaboratory study is as follows: Samples of the mixed fabrics are degreased by extracting with carbon tetrachloride. The degreasing can be carried out by extracting the samples for 2 hours in a Soxhlet apparatus siphoning over at least six times, or by the more convenient single 2-hour immersion in the solvent contained in an ordinary beaker. After the treatment with carbon tetrachloride, the sample is air dried and thoroughly rinsed three times with hot distilled water at 50° C.

Approximately 2 grams of the degreased sample is dried to constant weight. The weighed sample is then

immersed in 200 ml., or 100 times the weight of the sample, of a boiling 1% solution of sulphuric acid for 7 to 10 minutes. (This solution, which is 1% by weight and contains 1 gram of H_2SO_4 in 100 grams of solution, can be prepared by adding 5.9 ml. of concentrated 93% H_2SO_4 to 990 ml. of water.)

The sample is then transferred to a Buchner or Hirsch funnel, 45 mm. in diameter, and the excess acid solution removed by suction. It is allowed to cool, held over a 400-ml. beaker, and carefully cut into strips and shreds approximately ⅛ by 1 inch.

Sulphuric Acid Treatment

Two hundred ml. of 70 ± 1% sulphuric acid solution at 100° F. is added and the whole allowed to stand 15 minutes with frequent stirring. (A 70% solution of sulphuric acid by weight, containing 70 grams of H_2SO_4 in 100 grams of solution, is equivalent to 55° Bé., 123° Tw., or 1.620 specific gravity at 60° F., and is easily prepared by carefully pouring 800 ml. of commercial oil of vitriol of 66° Bé. into 484 ml. of distilled or soft water, stirring and cooling to the desired temperature. This 70% acid is available commercially as 55° Bé. sulphuric acid and may be purchased from any of the chemical supply houses at a reasonable price.)

A 1-liter beaker is partly filled with 600 ml. of cold water and at the expiration of the 15 minutes the 70% acid solution containing the sample is cautiously but quickly poured into it. The 400-ml. beaker is rinsed with two 50-ml. portions of water which are added to the 1-liter beaker. The residue is then recovered by filtering the above solution in the Buchner or Hirsch funnel through a disk of bleached, unstarched 80/80 cotton print cloth, using suction. The sample is rinsed with several portions of cold water, sucked reasonably dry, and the whole pad, including disk and fibers, is then carefully lifted out of the funnel by means of tweezers, dropped into 200 ml. of a cold 2% solution of sodium bicarbonate, and neutralized for 5 minutes. It is again collected on the same filter

disk in the funnel, rinsed with several portions of cold water, sucked reasonably dry, and the disk lifted out and placed in a warm, sheltered spot to dry. The object of this preliminary drying is to facilitate the transfer of the fiber mass from the cotton filter disk to the weighing bottle. When dry, the recovered fiber mass is carefully transferred to a weighing bottle, placed in the drying oven and dried to constant weight. Results should be calculated on an oven-dry basis. For routine tests, the average of results obtained by analysis of two or three samples is sufficiently precise.

Closeness of Results

The accompanying table shows the closeness of results obtained by five cooperating laboratories in analyzing samples of a mixed fabric containing approximately two-thirds wool and one-third rayon.

A detailed discussion of the inter-laboratory study appears in a report: "The Sulphuric Acid and Aluminum Chloride Carbonization Methods for the Determination of Wool in Mixed Fabrics Compared in an Inter-laboratory Study," in the July 7, 1941, issue of the *American Dyestuff Reporter*. The report was prepared by Lillian E. Weidenhammer, U. S. Bureau of Home Economics; F. A. Prisley, Hayward-Schuster Woolen Mills; and Bertil A. Ryberg, associate director of research, American Association of Textile Chemists & Colorists.

Percentage of wool in rayon-wool mixture reported by five cooperating laboratories

Sample	Lab. A	Lab. B	Lab. C	Lab. D	Lab. E
1	64.9	63.6	59.3	62.7	62.8
2	64.6	64.2	62.6	62.6	64.0
3	65.4	63.9	63.3	62.5	62.8
4	64.8	63.9	63.1	62.5	63.5
5	64.8	64.1	63.0	62.2	64.0
Mean	64.9	63.9	62.3	62.5	63.4

EDITORIAL

What This Means to You

THIS FIRST ISSUE of the revitalized *Textile Research* is a symbol of the revitalized research program of the textile industry.

From now on, that program is going to be different. It is going to be an active, living part of the business of making money out of textile manufacture. And that, in the final analysis, is the business in which employers and employees are engaged.

This new program is no accident. It is the culmination of 20 years of thinking and planning. At the very start of the textile deflation following the last war, far-seeing men in the industry realized that the way out was through research. In 1930, two organizations were started, almost simultaneously: the Textile Foundation and the U. S. Institute for Textile Research. At long last, these two organizations have joined forces through a working arrangement which preserves the independent status of each, and yet insures complete coordination of effort toward one final goal: making research pay dividends to the textile industry.

What does this mean to you, Mr. Textile Manufacturer?

It means that research will no longer be an abstract phase to you. It will be a working instrument. The researches conducted by the Textile Foundation and other agencies will be translated into lay language and made available to you, for practical application in your mill.

It means that the U. S. Institute for Textile Research will be the channel through which academic theory will find practical expression. This magazine, *Textile Research*, will be one of the media for this transfer. Other means will include direct contact with mills, through research associates; regional organizations which will hold regular meetings in the various geographical sections of

the industry; cooperative researches on specific problems conducted by the Institute; and an Information Bureau which will become a central Clearing House for all questions involving textile research and its application.

It means dollars and cents to you. Research has paid dividends to every industry that has utilized it effectively. It will pay dividends to the textile industry.

All of this will take time and money. Research dollars have been called, aptly, patient dollars. But the end will more than justify the means.

Here is what you, Mr. Textile Manufacturer, can do to get your share of the dividends:

1. Sign up for a company membership.

2. Get your executives, sub-executives, and technicians to take out individual memberships.

3. Attend the annual meeting of the U. S. Institute for Textile Research, at the Hotel Roosevelt, New York, November 14, in full company force. Get your friends to come too. The new plan will be explained to you then in detail.

There is no better investment for you today than that of your time and interest and money in this revitalized textile research program.

Come and find out about it, on November 14.

Program of Annual Meeting

Outstanding feature of the annual meeting of the U. S. Institute for Textile Research on Friday, Nov. 14, at the Roosevelt Hotel, New York, is the luncheon session at 1 o'clock at which there will be a round-table discussion of the following subjects: (1) What's new in fundamental research and where does it fit into our program; (2) What textile people think of applied research—some specific suggestions; (3) A research information bureau for the textile and allied industries; (4) Business research, its significance in times like these; (5) A mill contact service; and (6) the revitalized TEXTILE RESEARCH.

Fiber Research Results in New Process With Which

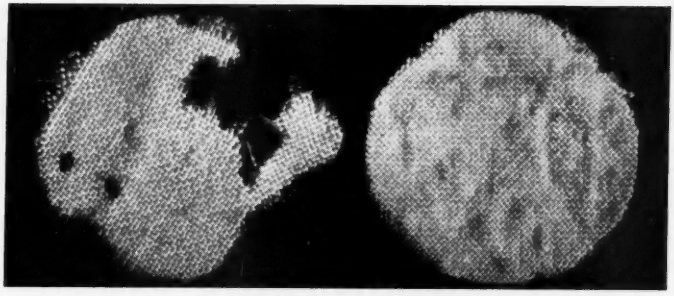
Wool Can Be Improved

By DR. MILTON HARRIS

Director of Research, Textile Foundation

PRODUCTION OF A WOOL which is strongly resistant to attacks by moths, bacteria, molds, and other biological agents; to shrinkage during laundering; to chemical agents, such as alkalies and sulphites; and to ageing by natural causes, such as sunlight, has now been achieved in the laboratories of the Textile Foundation at the National Bureau of Standards. This has been accomplished by a process involving the modification of the molecular structure of the natural fiber. The story of the development, which is still in the laboratory stage, is a fascinating one. It was a similar type of basic research on the modification of cellulose which resulted in the rayon industry. And the results of the present researches may have far-reaching results in the wool industry.

Wool has been of particular value in those branches of the textile industry manufacturing apparel fabrics, blankets, carpets, and felts—commodities which are important because of their properties of warmth or their resiliency; that is, their ability to regain their original length or shapes after they have been distorted. Actually, this resiliency of wool is primarily responsible for its warmth. For example, a cotton blanket would be as warm as wool if, instead of matting together in use, it would maintain a porous structure, as does a woolen blanket. The small air spaces in the porous texture are



Samples of wool cloth which have been exposed to moth larvae: left, untreated wool; right, modified wool

to a large degree responsible for the insulating properties of the woolen fabric.

Indeed, it can be stated that this long-range resiliency of wool is one of its all-important properties, and more than any other factor is the thing that gives wool a unique position in the textile industry. The great importance of this property is even better demonstrated by the efforts of those engaged in the production of regenerated and synthetic fibers. Whereas in former times the bulk of their efforts were devoted to improvement in strength of these fibers, a good part of the trend of their work has now shifted toward trying to increase the resiliency of these same fibers.

Spring-Like Structure

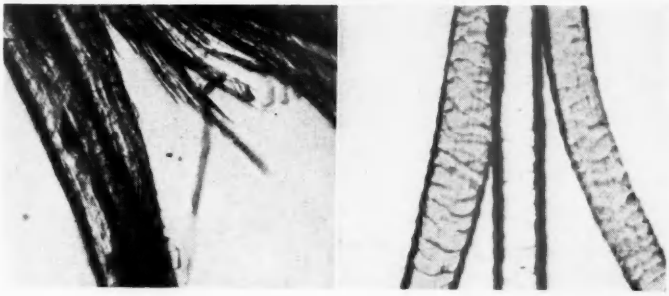
Extensive researches on wool have shown that this fiber owes its resilience to a spring-like molecular structure. This is in contrast to most of the other common fibers, which in reality resemble a bundle of closely packed extended strings, each of which is a long molecular chain. When such fibers are appreciably distorted, these long chains may move into new permanent positions, and this results in the permanent distortion of the fiber. The ease with which this can occur is one of the principal reasons why, for example, cotton materials crease so readily. The coiled molecules of wool fibers would also slide past each other and produce permanent distortion were it not for the fact that they are connected

at frequent intervals by short cross-chains to produce a three-dimensional or network structure. Thus, when wool is stretched or folded, the new chains do not slide out of position; rather tensions are set up which cause the fiber to return to its original shape after removal of the external force.

Although these cross-links contribute much to the unique properties of wool, they are also easily destroyed by many conditions and chemicals with which the wool is constantly coming in contact. The ease with which wool is damaged under a great variety of conditions can be readily traced to the ease with which the cross-links are broken. In other words, the role of these links is a Dr. Jekyll and Mr. Hyde role. On the one hand they contribute enormously to wool's important physical properties; on the other, they offer an entering wedge by which these properties can be impaired or the fiber ultimately destroyed.

This apparent dilemma led to the prediction that if these relatively unstable cross-links could be replaced by chemically stable ones, wool's familiar desirable properties could be retained and at the same time many of its weaknesses would be overcome. The research work thus far has definitely confirmed this prediction. It was found in the laboratory that these cross links can be ruptured with suitable reagents, although maintaining the

Photomicrograph at left shows degradation of untreated wool produced by enzymes; right, stability of chemically modified fibers under identical conditions



structure of the original fiber. The wool is then reconstituted by rejoining the stumps of the cross-links through treatment with another chemical reagent. Any desired number of links can be reconstituted, but alteration of about half of them confers the desired properties on the fiber.

The manner in which the resistance of wool to attack by moths has been increased is an interesting example of the effect of cross-links rebuilding. Under ordinary conditions, the cross-links of wool are broken in the digestive tract of the moth, which happens to be well on the alkaline side. After the links are cleaved, the wool protein is readily digested. Since, however, the rebuilt cross-links are stable to alkalies and other chemical reagents, the moth is unable to cleave them, and accordingly, the material is rendered indigestible.

Little can be said at this time regarding the economics of the process, since all experiments have been on a laboratory scale. It is hoped that a few small-scale mill experiments will be underway in the very near future. One of the chemicals used has not been available as an industrial chemical and, therefore, its cost is not readily computed. This need not be considered a deterring factor, since the textile industry now uses a great variety of chemicals which were formerly expensive laboratory reagents. Practically the sole requirement for a cheap chemical is volume demand.

As the process will necessarily add to the cost of the product, it appears that the modified wool will find its initial application in uses where the extra cost is warranted. In this respect, it may be considered analogous to the synthetic rubbers, which—although more costly than natural rubber—are in considerable demand because of their special properties, such as resistance to oil. It is anticipated that ultimately the cost of the processing will not exceed a few cents a pound. When this is accomplished, the new stabilized wool may well win a wide market for itself.

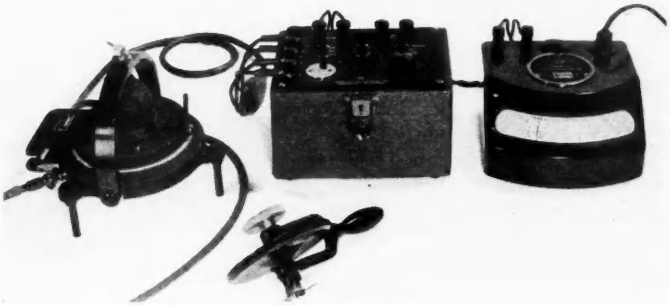
RESEARCH AIDS

Reagent for Identifying Fibers

Identification of textiles is facilitated by development of a new universal indicator which gives different color reactions with different fibers. The indicator is supplied in 1-oz. bottles ready for use, and can be used over and over until the liquid is exhausted. With this indicator, samples of fibers are immersed in the liquid, allowed to stand for 3 to 5 min., rinsed in running water, passed through a dilute solution of ammonia, again rinsed, dried, and compared for shade with a color chart supplied for use with the indicator. The indicator, known as Colortex B, is said to be superior to the well-known indicator Neocarmine W, which is no longer obtainable in this country. It is made by General Chemical Mfg. Co., and is distributed by Neuberg Chemical Corp., 441 Lexington Ave., New York.

Gas Permeability Tester

For testing the permeability of fabrics to gases, a new type of apparatus has been developed recently which utilizes the thermal conductivity method of gas analysis and indicates the rate of permeation in terms of liters per square meter per 24 hours of the retained gas. One application of the apparatus for testing the rate of diffusion of hydrogen, helium, carbon dioxide, etc., through balloon fabrics; lateral diffusion as well as leakage at seams can be determined. The equipment can be employed also for a wide variety of other coated and impregnated fabrics for either military or civilian use. The sample to be tested is clamped between two recessed test plates, thereby forming upper and lower compartments separated by the fabric being tested. The plates are designed so as to keep the fabric from sagging and thus insure identical volumes of the two compartments;



Fabric Permeator

the gas is passed into the lower compartment. The upper compartment, which is filled with clean, dry air, communicates with the metering unit. The gas which permeates through the fabric contaminates the air in the upper compartment and thus changes its thermal conductivity. A measure of the rate of this contamination provides a measure of the ability of the fabric to hold gas. The metering unit in the test plate assembly is connected through a control box to a portable calibrated, direct-reading spot galvanometer.

The instrument, called the Fabric Permeator, was developed by Cambridge Instrument Co., Inc., Grand Central Terminal, New York.

Wide-Range pH Test Paper

For use in pH control a series of wide-range test papers have been made available recently, together with a convenient dispenser for the papers. The test papers cover a range from pH 1 to pH 14 and are supplied either in strips or in 15-ft. rolls. The dispenser holds two rolls of paper and incorporates a color chart which is visible through transparent walls. Ordinarily types A and B paper are furnished with the dispenser to permit read-

ings from pH 1 to pH 11. Three other types give distinct color changes at pH 11–12, pH 12–13, and pH 13–14, respectively. Results are said to be accurate within 0.5 pH units. The dispenser is of vest-pocket size and is refillable. The outfit is manufactured by Micro Essential Laboratory and distributed by R. P. Cargille, 118 Liberty St., New York.

Research: A Vast Force

If anyone needs to be converted on the subject of research, he should read "Lives and Dollars," * by J. D. Ratcliff. Out of the pages of this book pours a veritable stream of ideas and inventions, touching on so many of the elemental needs of man that the reader gets the impression of a vast force working constantly with astonishing ingenuity to solve the great problems of health, food, wealth, and living.

When these solutions are produced, we are inclined to accept them almost as phlegmatically as we endured the afflictions before-hand, little realizing that behind each of these colorless serums, these versatile plastics, these insect parasites, etc., lies a story of quest and discovery as thrilling as, and usually far more significant than, the voyage of a Magellan. It is these human stories of the latest developments in science that Mr. Ratcliff tells in this book.

The first part is devoted to those discoveries which save lives by the prevention or cure of disease. The second part deals with discoveries and inventions in the industrial fields—the dollar-saving discoveries. All of the book is fascinating, but naturally it will be the second part which will be of primary interest to the readers of this publication.

* *LIVES AND DOLLARS: A Story of Today's Research, by J. D. Ratcliff; Dodd, Mead & Co., New York; $3.*

Textile Foundation Studies Point the Way to Sound

Inventory Policies

By HIRAM S. DAVIS
Industrial Research Dept., University of Pennsylvania

TEXTILE MILLS cannot afford to assume that they have moved into a new economic era free of the problems which beset them in the 30's. At any time political or military events may bring about a virtual cessation of buying; and then the flood of orders will turn into a torrent of deferments, requests for contract adjustments, returns, cancellations, and other well-known devices of shifting inventory load. No one can assume that present conditions are permanent; perhaps the need for war-time production will persist longer than is now anticipated, but every day that passes brings us nearer the painful process of transition from a war-time to a peace-time economy.

We are now committed to the complete defeat of Nazi Germany—no risk can be taken that our supply of war materials will not be equal to the task, even if it means over-preparation. But sooner or later both military and civilian buyers will wake up to find that they have over-anticipated their requirements. It was that way at the end of the last war, and it is even more likely to be so at the end of this war.

Accordingly, textile executives will do well to consider what production and inventory policies they are going to follow once demand begins to waver. As a guide to their thinking and planning, they will find highly

useful a series of studies which the Textile Foundation is publishing under the general title of "Inventory Policies in the Textile Industries." This series not only appraises how textile mills met their inventory problems in recent years, but it also discusses both inventory policies and statistical guides for the 1940's.

Acting on the recommendation of the committee on economic research of the U. S. Institute for Textile Research, about two years ago the Textile Foundation invited the Industrial Research Department of the University of Pennsylvania to undertake a study of inventory policies in the textile industry. The results of this investigation are now being made available in a series of monographs dealing with both general and specific inventory problems of the several branches of the textile industry. The broad range of subjects covered is shown by the list of titles on the next page.

Manufacturing to Order

On the subject of policies, the reports consider the merits of manufacturing to order such diverse fabrics as fine goods and print cloths. Planning of production is also appraised and its possibilities are set forth for both denims and print cloth. Discussing delayed specifications, cancellations, and other devices of shifting inventory risk, the point is made that the wool textile industry might do well to consider a policy of selling for spot delivery instead of waiting to manufacture merchandise until the buyer makes up his mind, as was the traditional practice during the 30's. How selling to different types of customers requires different production and inventory policies is appraised in both the rayon weaving and the full-fashioned hosiery industries. A check list of all the factors that are important in determining inventory policy, which appears in the last report of the series, will be highly useful to individual mills in reviewing their own policies.

The study deals with the inventory policies of distributors, as well as of mills. Many textile executives

may have assumed that all chains prospered alike during the 30's. This study reveals, however, that there were important differences in the sales and inventory experience of the various retail chains important to textile distribution.

Attention is given to inventory and sales trends among various types of independent distributors, with the general conclusion that retailers of all types learned how to do business with less merchandise during the 30's. From the viewpoint of the textile manufacturer, this policy means that it is difficult for mills selling direct to distributors to keep out of the "warehouse" business.

A feature of the reports is a program recommended for the collection of statistics on the operations of converters, fabricators, and distributors. Thousands of re-

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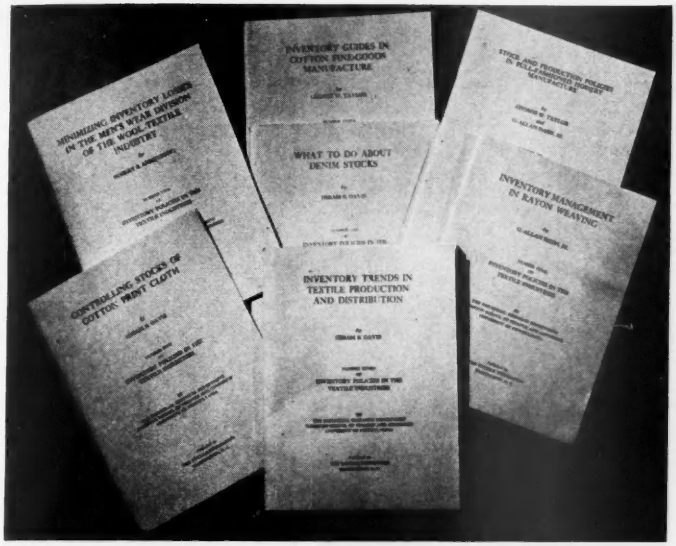
Titles of Monographs on Inventory Policies

1. **What to do About Denim Stocks**—A Case Study of Inventory Problems in the Manufacture of Staple Finished Goods.
2. **Minimizing Inventory Losses in the Men's Wear Division of the Wool-Textile Industry**—An Appraisal of the Policy of Manufacturing Styled Finished Goods to Order.
3. **Inventory Guides in Cotton Fine-Goods Manufacture**—An Analysis of Mill Experience in Producing Staple and Styled Gray Goods.
4. **Inventory Management in Rayon Weaving**—A Comparative Analysis of the Policies of Selling Styled and Staple Gray Goods from Stock and From Production.
5. **Controlling Stocks of Cotton Print Cloth**—Some Problems of Inventory Management in the Manufacture of Multi-Purpose Gray Goods.
6. **Stock and Production Policies in Full-Fashioned Hosiery Manufacture**—The Experience of Textile Mills Selling a Consumer Product.
7. **Inventory Trends in Textile Production and Distribution**—An Appraisal of Experience During the 1930's.


MINIMIZING INVENTORY LOSSES IN THE MEN'S WEAR DIVISION OF THE WOOL TEXTILE INDUSTRY
INVENTORY GUIDES IN COTTON FINE-GOODS MANUFACTURE
WHAT TO DO ABOUT DENIM STOCKS
INVENTORY MANAGEMENT IN RAYON WEAVING
CONTROLLING STOCKS OF COTTON PRINT CLOTH
INVENTORY TRENDS IN TEXTILE PRODUCTION AND DISTRIBUTION

Series of seven reports on inventory policies

ports are not needed according to this analysis. In the case of the cotton-textile industry, it is stated that the co-operation of less than 100 firms would probably give an adequate picture of current and prospective conditions at the converting, fabricating, and distributing levels. To put such a program into effect, creation by the textile industries and related trades of an independent statistical agency managed by an inter-trade board, is suggested.

The best statistical guide for mill purposes, according to the reports, is the commitment position of those who convert, fabricate, and distribute textile mechandise. Next in importance are the commitments of each industry's own immediate customers broken down by delivery month. Other statistical guides appraised include billed-and-held stocks and unsold mill stocks.

(Copies of the monographs are available at 50c each or at $3 for the complete set from the Textile Foundation, Industrial Bldg., National Bureau of Standards, Washington, D. C.—*Editor.*)

RESEARCH BRIEFS

INCREASING TENSILE STRENGTH OF WOOL, repairing damage to animal fibers which have been injured during crabbing or by exposure to light, and obtaining better results in fulling are discussed in an article, "The Chemistry of Wool and Related Fibers," by J. B. Speakman, of Leeds University, in the July, 1941, issue of the *Journal of the Textile Institute.* The author states that although knowledge of wool and wool processing advanced from a state of empiricism to one of scientific precision in the interval between two world wars, the industrial significance of this is appreciated by only a few. The first part of the article summarizes recent advances in the chemistry of animal fibers and is of particular interest to research workers. The second part deals with the technical significance of these advances and merits the careful attention of all executives of woolen and worsted mills.

A NEW METHOD for determining the grease content of raw wool is described by Herbert J. Wollner, U. S. Treasury Department, in an article, "Sampling and Testing Wool," in the September, 1941, issue of *Textile World.* This method is being used in a laboratory established in Boston by the Bureau of Customs, for testing samples of all imported dutiable wools. Article is of interest to all concerned with purchasing or testing of wool.

RESEARCH ISN'T LIKE A SAUSAGE MILL; you cannot put brains in one end and grind out profitable ideas at the other. You must accumulate small ideas patiently, hoping eventually to fit them together into something big. Ten years may elapse before the laboratory produces anything worthwhile. Thus spoke Dr. C. E. K.

Mees, when George Eastman went to England in 1912 to hire Mees to head the Eastman Research Laboratories. Mees got the job, but Eastman had to wait 11 years for home movies, the first major development of Mees's laboratory. Today Eastman's budget for experimental work is $5,000,000; research expenditures represent 25 cents of every dollar of earnings. Eastman thrives on research; sales in 1939 of cellulose acetate plastics alone approximated $20,000,000. Dr. Mees insists that his research men be given complete freedom. "The man who knows most about any project," he says, "is the man doing the job. The man immediately above him knows a little less; the research director, still less. By the time you get up to a committee of vice-presidents they know precisely nothing."—Digested from September, 1941, *Reader's Digest*, condensation of an article, "Eastman's Magic Wand of Research," by J. D. Ratcliff, in the June 23, 1941 issue of *Barron's*.

THE WARMTH OF FABRICS, a new method for measuring thermal transmission, and result of tests made by that method on various types of materials are discussed by W. Howard Rees, of the British Cotton Industry Research Association, in an article, "The Transmission of Heat Through Textile Fabrics," in the August, 1941, issue of the *Journal of the Textile Institute*.

DULLING OF CHROME DYEINGS produced in iron dyeing machinery can be avoided by forming a protective oxide film on the surface of the metal with aid of chromate or dichromate, according to C. L. Bird and E. Molloy, of the Dyeing Department, Leeds University, in an article "Prevention of Dull Shades Due to the Presence of Iron in the Dyebath when Dyeing with Chrome Dyes," in the July, 1941, issue of the *Journal of the Society of Dyers & Colourists*. The pro-

tective film can be built up, for example, by cleaning the inside surface of the kettle with emery paper, filling the machine with a 0.005% solution of potassium dichromate, and boiling for 1 hour. As it is necessary to have chromate or dicromate present during dyeing in order to repair weak places in the film, 0.005% dichromate is added to the dyebath. Sulphuric acid destroys the film. Presence of 0.02 to 0.05% of acetic acid (30%) does not seriously affect the adequacy of the film.

EXTENSIVE RESEARCH carried out over a period of several months has shown that ultra-violet radiation properly installed may bring about a high degree of fabric sanitization and also result in a reduction of mold and mildew problems, it is stated in a report, "Textile Application of Selective Ultra-Violet Radiation," prepared by W. S. Marsh, of United States Testing Co., and released by that company.

PREVENTION OF SPOTS in cotton fabrics due to contamination of cotton from bale ties painted with asphalt solution, is discussed by Dr. Otto Morningstar, in a research report, "Spots in Cotton Fabrics," issued recently by the Alabama Cotton Manufacturers Association.

APPEARANCE is an element of cotton yarn quality which varies in importance according to which the yarn is to be put, according to Malcolm E. Campbell, senior cotton technologist, U. S. Department of Agriculture in an article, "Standards for Appearance of Cotton Yarn," in the Sept. 1, 1941, *Textile Bulletin.* Article discusses factors influencing yarn appearance and describes use of photographic standards developed for judging yarn appearance.